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CHEMICAL REACTIONS IN POLYCRYSTALLINE ICE (ABSTRACT)

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The acceleration mechanism of chemical reactions by freezing has been investigated in the reaction of nitrite with dissolved oxygen to form nitrate. The reactants are concentrated into the unfrozen solution between ice crystals. In such a solution the reactants are further concentrated, and the pH of the solution decreases due to proton transfer from the ice to the solution to relax the freezing-potential that is generated. As a result, the reaction of nitrite with dissolved oxygen is accelerated considerably in freezing. To confirm this mechanism the reaction was investigated at various temperatures. At lower temperature than –3°C, nitrate formed rapidly until the sample was completely frozen, while the reaction did not proceed after the sample was completely frozen. On the other hand, at higher temperature than –3°C nitrate formation was still observed even after the sample was completely frozen. The reactants were not very concentrated because the unfrozen solution was equilibrated at that temperature at low concentration of the reactants due to freezing point depression. The concentration factor of the reactants at the temperature of –3°C was estimated to be several thousand.

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